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P A R T II.

P H Y S I C A L P A P E R S.

- I. *Observations upon an Hypothesis for solving the Phenomena of Light : with incidental Observations, tending to shew the Heterogeneousness of Light, and of the electric Fluid, by their Intermixture, or Union, with each other.*

By JAMES BOWDOIN, Esquire,

President of the American Academy of Arts and Sciences.

IN reviewing some letters I had written to a philosophical friend, Dr. *Franklin*, there occurred on the subject of one of them some observations, which appeared to me new. They are principally contained in the two last of three memoirs; which I shall lay before the Academy : to whose judgment it will be submitted, whether they have any thing beside their novelty to recommend them.

As they were occasioned by considering Dr. *Franklin's* queries concerning light, the strictures on those queries, as being introductory to the observations, will make a part of these memoirs.

The first memoir will accordingly contain a few strictures, or cursory remarks, on his hypothesis for solving the phenomena of light : with incidental observations concerning the heterogeneousness of light, and the electric fluid.

It is offered in full confidence, that our celebrated countryman, whose happy genius has contributed so largely to the advancement of philosophic knowledge, will be pleased with any attempt for that purpose, whether successful or not, even though it should be upon principles, that may not perfectly harmonize with some of his own.

The Doctor, dissatisfied with the received doctrine concerning light, offers several objections to it in the form of queries ; and in the same form proposes an hypothesis of his own : both of which will be considered.

With respect to the hypothesis, it is asked—* “ May not all the phenomena of light be more conveniently solved, by supposing universal space filled with a subtle elastic fluid, which, when at rest, is not visible, but whose vibrations affect that fine sense in the eye, as those of air do the grosser organs of the ear ? We do not, in the case of sound, imagine that any sonorous particles are thrown off from a bell, for instance, and fly in straight lines to the ear : why must we believe that luminous particles leave the sun, and proceed to the eye ? Some diamonds, if rubbed, shine in the dark, without losing any part of their matter. I can make an electrical spark as big as the flame of a candle, much brighter, and therefore visible further ; yet this is without fuel : and I am persuaded no part of the electric fluid flies off in such case to distant places, but all goes directly, and is to be found in the place to which I destine it.—May not different degrees of the vibration of the above-mentioned universal medium, occasion the appearances of different colours ? I think the electric fluid is always the same ;
yet

* See Letters and Papers on Philosophical Subjects. p. 265. edit. 1769.

yet I find that weaker and stronger sparks differ in apparent colour : Some white, blue, purple, red ;—the strongest, white ; weak ones, red.”

Several objections here present themselves. Some of them arising from the hypothesis itself ; and others from the comparison of light with sound.

In respect of the former, if universal space be filled with a subtle elastic fluid, (so as to exclude any vacuum) that fluid must always be at rest, and therefore by the hypothesis always invisible ; and consequently there would always be universal darkness. Or if any part of the fluid could be put in motion, the whole of it must be in motion : for not one particle of it could move, without moving, in the direction of its motion, the adjoining one, and this the next ; and so on, *ad infinitum*. In this case, the least motion, wherever it might commence, must produce universal motion ; and consequently, universal light : between which, and universal darkness, there could be no medium.

But if the meaning of the expression be, what it was probably intended to be, that universal space, instead of being filled, doth greatly abound, with an elastic fluid, then would not every thing, which disturbed that fluid, cause a luminous appearance ? Would not the inhabitants of the sea and air, in all their motions, bespangle both ; and thereby exhibit the various colours according to the different degrees of vibration, which those motions might occasion in the elastic fluid ?—As to ourselves, would not a radiance attend us wherever we went ? What occasion should we have of candle-light, when a quick vibration of the hand, or of machines made for that purpose, would dispel the night ? Or rather, might we not suppose
there

there would be no night at all ? for the action of the sun (if the sun should be necessary) would be communicated to us, notwithstanding the interposition of the earth. And would not the effect of that action, even at noon when most direct, be only to enlighten us, unattended with heat, so essentially necessary to enliven and invigorate the animal and vegetable world ?—Would not the elastic fluid, instead of exhibiting a round luminous body, which we call the sun, be itself a continued universal blaze of light ? And would not this, in the present constitution of things, obstruct vision, and totally alter the science of optics ?

The objections, implied in the foregoing queries, seem deducible from the hypothesis. There are several, which appear to arise from the comparison of light with sound.

1° As sound (or a vibrating, or undulating, motion in the air, which I consider here as synonymous) is propagated from the sonorous body in all directions ; and surrounds, and is propagated beyond or behind any obstacle in its way : so light, if it was a vibration, or undulation, of the elastic fluid, would surround, and be propagated behind an obstacle, like sound : but this does not agree with the fact.—2° As sound, or the vibrating motion in the air, originating in a house or any other inclosure, would, from a hole in one of the sides of it, be propagated externally, in circles, of which the hole would be the centre : so light, if it was a vibration, or occasioned by a vibration, of the elastic fluid, after passing through a hole, would be propagated in circles, of which the hole would be the centre. But this does not correspond to the fact : for light, in passing through any uniform medium, always passes in right lines.

Beside these, an objection similar to one of those, which have been advanced against the common hypothesis, and which may be seen in the proper place, may be alledged against this : for the constant vibration, with which the elastic fluid must be agitated, would communicate to small bodies, and even to large ones suspended in that fluid, a constant tremulous vibratory motion. In such a case it would be difficult to examine the texture and visible qualities of those small bodies, as one necessary mean of examination, a great deal of light, would encrease the vibration ; and thereby render the examination not only difficult but impracticable. It is apprehended, however, that no such motion, or embarrassment, in the making of such examinations, has ever been observed.

What is mentioned about the electrical spark, that it is bright, and visible at a distance, and this without fuel ; and that no part of the electrical fluid flies off, in such case, to distant places, but all goes directly, and is to be found in the place, to which it is destined, appears to favour the hypothesis ; as the implied inference seems to be, that the visibility of the electric spark arises from the vibration it produces in the universal elastic fluid. But if the foregoing queries furnish sufficient reason for doubting the existence of such a fluid, or for doubting such an effect from it, supposing its existence, will they not furnish equal reason for doubting the hypothesis ?

The visibility of the electric spark may be accounted for, upon the principles of the received doctrine concerning light, without supposing any diminution of the pure electric fluid in the spark : no part of which, it is said, flies off in the case mentioned.

It seems not improbable, that the electric fluid is heterogeneous as well as light.

The heterogeneity of light is inferred from its colours, which are said to vary proportionably, as the size of the particles doth vary: the variation becoming conspicuous by a prism, and by other means, which class the particles according to their respective magnitudes, or degrees of refrangibility, and reflexibility.

Beside this, another reason may be suggested, from which the heterogeneity of light may be deduced: namely, because it exhibits effects similar to some of those of electricity. For example, a globe or pane of glass warmed in the sun or before a fire, will successively attract and repel small cork balls, down, and such like bodies insulated, and properly circumstanced; and will shew other signs of electricity communicated to the glass by the sun or fire.

So, in regard to electricity, its heterogeneity may be collected from its producing effects resembling some of those of light or fire; which are here considered as equivalent terms.

Electricity and fire differ in many respects, and in some they agree; as hath been shewn in Dr. *Franklin's* letters on electricity. So far as they agree in their effects, their nature may be presumed to be alike: Or rather, from that agreement and similitude of effects, I think it may be inferred, that they are mixt with, and generally do accompany each other; and that each produces its own effect at the time of their joint operation. The effects of electricity, similar to those of fire, being produced by the fire mixt with it; and the effects of fire, resembling those of electricity, being produced by the electricity mixt with that: the compound taking its name from the predominant principle.

Thus,

Thus, fire inflames bodies, and throws its particles of light at a distance. Hence, the explosion of gun-powder, and the luminous appearance, occasioned by the electric spark : the fire mixt with it producing those effects.

Thus also, electricity attracts and repels certain small bodies alternately, under given circumstances. Hence, the alternate attraction and repulsion of glass, and some other things, heated by fire : the electricity mixt with the communicated fire producing those effects.

In this way I would infer the heterogeneity of light and electricity, and their mixture with each other ; and in this way account for the similitude and difference of their effects ; and for the luminous appearance or visibility of the electric spark in particular, without diminishing the pure electric fluid contained in it : all of which, in the case referred to, is said to go directly, and is to be found in the place, to which it was destined.

On the same principles the shining of diamonds in the dark when rubbed, and thereby electrified, may be accounted for, without supposing they loose any part of their matter.

In regard to the different colours of the electric spark, which are more or less strong according to the strength of the spark, they correspond to the different colours of light or fire, which are more or less vivid according to the density or intenseness of that element. This sameness of effect shews a sameness of cause, or that the light or fire mixt with the electric spark produces those colours : whose strength or vividness being according to the bigness of the spark, or to its quantity of electric fluid, makes it probable, that in proportion to the quantity, there is more or less light or fire contained in that fluid.

These different appearances seem to be a further instance or proof of the heterogeneousness of the electric fluid ; and, taken in connection with other appearances above-mentioned, shew the intermixture, and the consequent heterogeneousness, of the two elements.

The next thing to be considered is, the objections to the received doctrine concerning light.—But this will be the subject of another memoir.

